Chemical Speciation of P from Band Applied P Fertilized Soil in Presence or Absence of Plant Growth.

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Introduction

There is limited information on how commercial phosphorus fertilizer application in a concentrated band impacts the solubility and transformation of phosphate compounds in presence or absence of plant growth in Canadian prairie soils. There has been little recent work to follow the fate and transformations (speciation) of applied fertilizer P in prairie soils. Thus, A combination of wet chemical analysis and synchrotron based techniques were used to reveal chemical speciation of soil phosphorus (P) when inorganic fertilizer P is placed in the soil in a band in presence or absence of plants under field conditions.

Objective

To employ a synchrotron technique to assess the fate of fertilizer P forms added to prairie soils.

Materials and Methods

Field Study

A field experiment was conducted in on a loamy Brown Chernozem in Saskatchewan. Bands were applied in field using a John Deere 610 air seeder at 30-cm row spacing with a Dutch Industries banding knife that creates a 2.5-cm wide band at a depth of 10 cm into which the fertilizer is placed.

Treatments

Monoammonium Monoammonium phosphate (MAP) blended with urea as inorganic fertilizer was used in this study. The band plot was set up with a single application of a blend of urea and monoammonium phosphate. The fertilizer was a blend of 66% urea (46-0-0) and 33% MAP (12-51-0), giving a blend analysis of 34-17-0 that was applied at a rate of 54 kg N ha^{-1} and 12 kg P ha^{-1}, a typical rate of N and P application for the region.

Sample Collection and Lab Analysis

Intact horizontal soil profiles were collected using a nailboard monolith technique and stored at -20 ^{0}C. Soil samples were then collected from each monolith using a micro-coring device starting at the center of the band and at 5-cm intervals away from the band center (Fig. 1). The collected soil samples were air-dried, ground, and analyzed for P forms by P K-edge XANES spectroscopy and available P was determined using modified Kelowna extraction method. The P XANES spectra of all the soil samples was conducted at the Soft X-ray Micro-characterization beamline (SXRMB) at the Canadian Light Source (CLS).

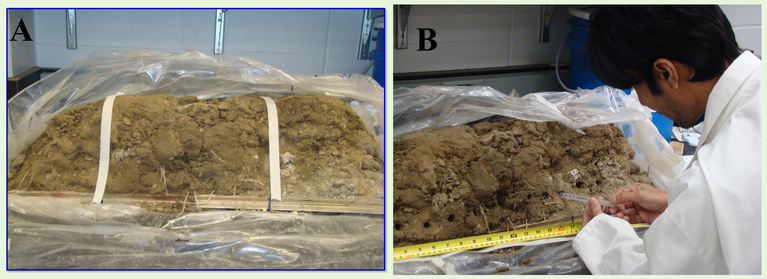

Figure 1: intact monolith (A) and Soil sample collection (B) used for soil P speciation.

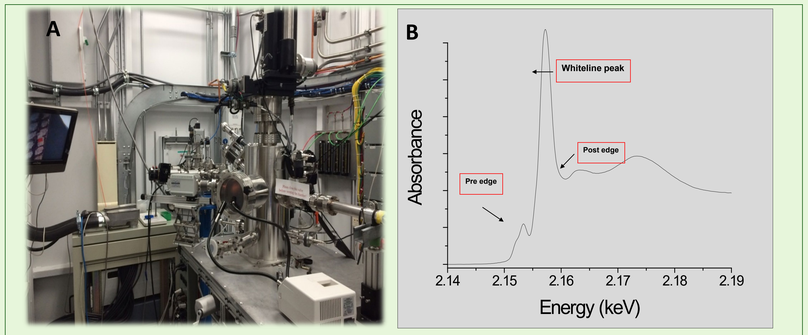

Fig. 2. SXMRB beamline end station (A) and collected data (B)

Results

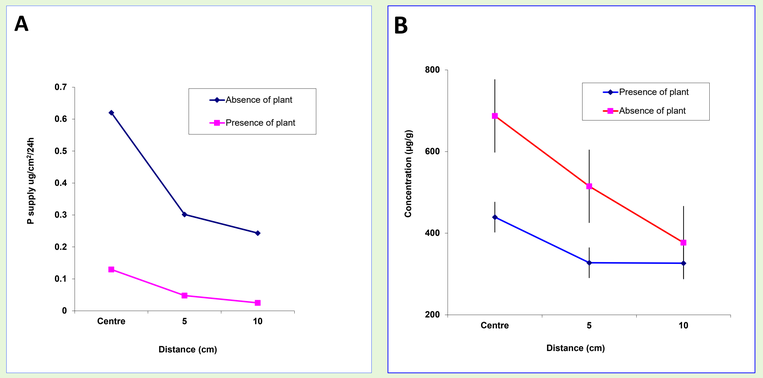

Figure 3: Labile (A) and total (B) P in soils as a function of P source, distance from injection zone

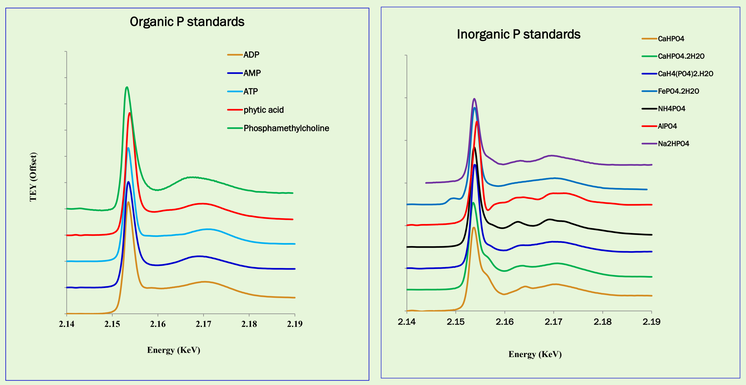

Figure 4: Normalized and background subtracted P K-edge XANES spectra of phosphate standards.

Table 1. Linear combination phosphorus X-ray absorption near edge structure (P XANES) fitting results and labile P fractions showing proportions of P compounds in the fertilized (MAP) soils.

Soil Sample	Brushite	Apatite	Absorbed P	Mono CaP	Labile P
			%		
Presence of Plant					
Centre		31	69		0.3
5 cm		36	64		0.2
10 cm		22	15	63	0.08
Absence of Plant					
Centre		33	73		0.81
5 cm	10	36	54		0.72
10 cm		46	54		0.41

Discussion

❖ Total P and labile P supply rates are highest in band center and decrease rapidly with distance due P movement to limited mobility of P and lower total P and labile P supply rates in presence of plants indicates the available P uptake by plants in this time frame.

❖ Spectra in center sample is different from P in source material inorganic fertilizer: Ortho-P in fertilizer has reacted with calcium and carbonates to form new reaction products that increased the insoluble P compounds.

❖ Only monocalcium phosphate was observed in presence of plant at 10 cm away from the band.

Conclusion

❖ Total P and labile P supply rates are highest in band center and decrease rapidly with distance away from band and lower total P and labile P supply rates in presence of plant.

❖ adsorption and precipitation were dominant retention mechanisms at the band center while precipitation reactions were dominant further away from the band center

Acknowledgements

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